



US006132979A

United States Patent [19]**Murakami**[11] **Patent Number:** **6,132,979**[45] **Date of Patent:** ***Oct. 17, 2000**[54] **CYTOTOXICITY TESTING METHOD**[75] Inventor: **Toru Murakami, Tokyo, Japan**[73] Assignee: **NEC Corporation, Tokyo, Japan**

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: **09/085,647**[22] Filed: **May 27, 1998**[30] **Foreign Application Priority Data**

May 27, 1997 [JP] Japan 9-136886

[51] Int. Cl.⁷ **G01N 33/567**[52] U.S. Cl. **435/7.21**

[58] Field of Search 435/240.243, 174, 435/176, 177, 178, 179, 180, 181, 182, 240.22, 240.23, 240.1, 226, 29, 721, 395, 305.1, 32, 11, 25; 424/574; 436/34

[56] **References Cited**

U.S. PATENT DOCUMENTS

5,066,580	11/1991	Lee	435/7.21
5,175,092	12/1992	Gabriels, Jr.	435/29
5,221,622	6/1993	Chen	435/226
5,314,805	5/1994	Haugland et al.	435/29
5,470,739	11/1995	Akaike et al.	435/402
5,534,416	7/1996	Millard et al.	436/34
5,573,942	11/1996	Miyamoto	435/402

5,591,627	1/1997	Miyamoto	435/289.1
5,597,703	1/1997	Murakami	435/25
5,602,029	2/1997	Miyamoto	435/395
5,654,135	8/1997	Tinois et al.	24/93.1
5,702,915	12/1997	Miyamoto	435/32
5,736,352	4/1998	Murakami	435/11
5,792,945	8/1998	Murakami	73/64.48

FOREIGN PATENT DOCUMENTS

63-295963	12/1988	Japan	.
63295963	12/1988	Japan	.
5-336996	12/1993	Japan	.
7-123999	5/1995	Japan	.

OTHER PUBLICATIONS

Millard et al, 1995, Abstracts of the General Meeting of the American Society of Microbiology, vol. 95(0), p. 477, #Q440.

"Cytotoxicity Testing Methods", *The Institute of Tissue Culture Engineers of Japan*, 1991, Asakura Publishing Company, pp. 66-101, In Japanese.

Primary Examiner—James C. Housel

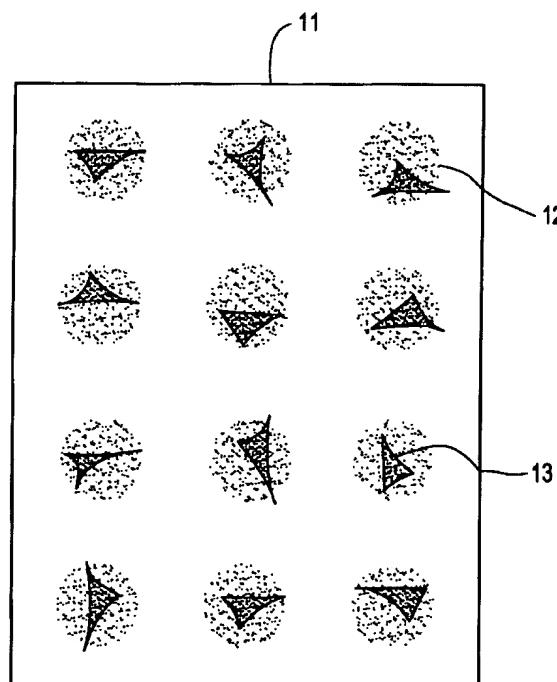
Assistant Examiner—Ginny Allen Portner

Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas, PLLC

[57] **ABSTRACT**

A cytotoxicity testing method of the present invention allows live cells to be directly and accurately counted one by one in order to determine the survival rate of cells. This allows the toxicity of a chemical substance to be quantized with high accuracy.

8 Claims, 2 Drawing Sheets



DOCUMENT-IDENTIFIER: US 6132979 A
TITLE: Cytotoxicity testing method

----- KWIC -----

BSPR:

A tenth cytotoxicity testing method determines whether cultured cells are alive or dead by flow cytometry. When a Trypan Blue solution is added to a cell solution, only dead cells take it thereinto. Trypan Blue absorbs red helium-neon laser light having a wavelength of 632.8 nm and issuing from a flow cytometer. Therefore, a sample consisting of a number of cells is instantaneously divided into three groups of spots, i.e., live cells, dead cells, and cell fractions. The three groups of spots are drawn on an oscilloscope and allow a ratio between live cells and dead cells to be easily determined. When Hoechst 33342 and propidium iodide are used to dye DNA of unfixed cells, live cells and injured cells fluoresce in blue and red, respectively and can therefore be easily distinguished by a flow cytometer.



US005827742A

United States Patent [19]**Scadden****[11] Patent Number:** 5,827,742**[45] Date of Patent:** Oct. 27, 1998**[54] METHOD OF SELECTING PLURIPOTENT HEMATOPOIETIC PROGENITOR CELLS****[75] Inventor:** David T. Scadden, Weston, Mass.**[73] Assignee:** Beth Israel Deaconess Medical Center, Inc., Boston, Mass.**[21] Appl. No.:** 299,902**[22] Filed:** Sep. 1, 1994**[51] Int. Cl.:** C12N 15/06**[52] U.S. Cl.:** 435/377; 435/2; 435/325; 435/366; 435/372; 435/375**[58] Field of Search:** 424/43.7, 529; 435/2, 240.1, 240.4, 325, 366, 376, 377**[56] References Cited****U.S. PATENT DOCUMENTS**

5,061,620 10/1991 Tsukamoto et al. 435/7.21
5,087,570 2/1992 Weissmann 435/240.1

FOREIGN PATENT DOCUMENTS

WO 93/25216 12/1993 WIPO .
WO 94/16715 4/1994 WIPO .
WO 94/11493 5/1994 WIPO .

OTHER PUBLICATIONS

Brandt, J. et al., "Role of c-kit Ligand in the Expansion of Human Hematopoietic Progenitor Cells," *Blood*, 79(3):634-641 (1992).

Katayama, N. et al., "Growth Factor Requirement for Survival in Cell-Cycle Dormancy of Primitive Murine Lymphohematopoietic Progenitors," *Blood*, 81(3):610-616 (1993).

Sawada, S. et al., "In Vitro Expansion of Human Peripheral Blood CD34+Cells," *Blood*, 82(12):3600-3609 (1993).

Skoda, R.C. et al., "Murine c-mpl: A Member of the Hematopoietic Growth Factor Receptor Superfamily that Transduces a Proliferative Signal," *EMBO J.*, 12(7):2645-2653 (1993).

Takimoto, C.H. et al., "Effects of 5-Fluorouracil Substitution on the RNA Conformation and in Vitro Translation of Thymidylate Synthase Messenger RNA," *J. Biol. Chem.*, 268(28):21438-21442 (1993).

Testa, U. et al., "Cascade Transactivation of Growth Factor Receptors in Early Human Hematopoiesis," *Blood*, 81(6):1442-1456 (1993).

Youssoufian, H. et al., "Structure, Function, and Activation of the Erythropoietin Receptor," *Blood*, 81(9):2223-2236 (1993).

Bodine, D.M. et al., "Long-Term In Vivo Expression of a Murine Adenosine Deaminase Gene in Rhesus Monkey Hematopoietic Cells of Multiple Lineages After Retroviral Mediated Gene Transfer Into CD34+Bone Marrow Cells," *Blood*, 82(7):1975-1980 (1993).

Smith, C. et al., "Purification and Partial Characterization of a Human Hematopoietic Precursor Population," *Blood*, 77(10):2122-2128 (1991).

Ogata, H. et al., "Separation of Hematopoietic Stem Cells Into two Populations and Their Characterization," *Blood*, 80(1):91-95 (1992).

Briddell, R.A. et al., "Further Phenotypic Characterization and Isolation of Human Hematopoietic Progenitor Cells Using a Monoclonal Antibody to the c-kit receptor," *Blood*, 79(12) (1992).

Wineman, J.P. et al., "CD4 is Expressed on Murine Pluripotent Hematopoietic Stem Cells," *Blood*, 80(7):1717-1724 (1992).

Abboud, M. et al., "Study of Early Hematopoietic Precursors in Human Cord Blood," *Exp. Hematol.*, 20:1043-1047 (1992).

Sprangrude, G.J. and Brooks, D.M., "Phenotypic Analysis of Mouse Hematopoietic Stem Cells Shows a Thy-1-Negative Subset," *Blood*, 80(8):1957-1964 (1992). Orlic, D. and Bodine, D.M., "Pluripotent Hematopoietic Stem Cells of low and High Density Can Repopulate W/W' Mice," *Exp. Hematol.*, 20:1291-1295 (1992).

Craig, W. et al., "Expression of Thy-1 on Human Hematopoietic Progenitor Cells," *J. Exp. Med.*, 177:1331-1342 (1993).

Sroui, E.F. et al., "Long-Term Generation and Expansion of Human Primitive Hematopoietic Progenitor Cells In Vitro," *Blood*, 81(3):661-669 (1993).

Okada, S. et al., "Sequential Analysis of Hematopoietic Reconstitution Achieved by Transplantation of Hematopoietic Stem Cells," *Blood*, 81(7):1720-1725 (1993).

Andrews, R.G. et al., "CD34+Marrow Cells, Devoid of T and B Lymphocytes, Reconstitute Stable Lymphopoiesis and Myelopoiesis in Lethally Irradiated Allogenic Baboons," *Blood*, 80(7):1693-1701 (1992).

Rice, A. et al., "5-Fluorouracil Permits Access to a Primitive Subpopulation of Peripheral Blood Stem Cells," *Stem Cells*, 11:326-335 (1993).

McNiece, I.K. et al., "Detection of a Human CFC With a High Proliferative Potential," *Blood*, 74(2):609-612 (1989).

Li, C.L. and Jonnson, G.R., "Long-Term Hemopoietic Repopulation by Thy-1¹⁰, Lin⁻, Ly6A/E⁺Cells," *Exp. Hematol.*, 20:1309-1315 (1992).

Gabbianelli, M. et al., "Pure Human Hematopoietic Progenitors: Permissive Action of Basic Fibroblast Growth Factor," *Science*, 249:1561-1564 (1990).

Ploemacher R.E. and Brons, N.H.C., "In Vivo Proliferative and Differential Properties of Murine Bone Marrow Cells Separated on the Basis of Rhodamine-123 Retention," *Exp. Hematol.*, 16:903-907 (1988).

Sprangrude, G.J. et al., "Purification and Characterization of mouse Hematopoietic Stem Cells," *Science*, 241:58-62 (1988).

Jones, R.J. et al., "Separation of Pluripotent Hematopoietic Stem Cells from Spleen Colony-Forming Cells," *Nature*, 347:188-189 (1990).

(List continued on next page.)

Primary Examiner—Lila Feise

Assistant Examiner—Phillip Gambel

Attorney, Agent, or Firm—Lahive & Cockfield, LLP

[57]**ABSTRACT**

Methods of selecting a population of human cells containing quiescent pluripotent hematopoietic progenitor cells substantially free of mature, human myeloid and lymphoid cells, the quiescent pluripotent progenitor cells obtained by these methods, and methods of using the pluripotent progenitor cells are described.

5 Claims, 5 Drawing Sheets

OTHER PUBLICATIONS

Cassel, A. et al., "Retroviral-Medicated Gene Transfer into CD34-Enriched Human Peripheral Blood Stem Cells," *Exp. Hematology*, 21:585-591 (1993).

Brenner, M.K. et al., "Gene Marking to Determine Whether Autologous Marrow Infusion Restores Long-Term Hemopoiesis in Cancer Patients," *The Lancet*, 342:1134-1137 (1993).

Van Beusechem, V.W. et al., "Retrovirus-Mediated Gene Transfer into Rhesus Monkey Hematopoietic Stem Cells: The Effect of Viral Titers on Transduction Efficiency," *Human Gene Therapy*, 4:239-247 (1993).

Brandt, J. et al., "Characterization of Human Hematopoietic Progenitor Cell Capable of Forming Blast Cell Containing Colonies In Vitro," *J. Clin. Invest.* 82:1017-1027 (1988).

Ophir, A. et al., "5-Fluorouracil and Mast Cell Precursors in Mice," *Exp. Hematology*, 21:1558-1562 (1993).

Gordon, M.Y., "Human Haemopoietic Stem Cell Assays," *Blood Reviews* 7:190-197 (1993).

Berardi, A.C. et al., "Isolation and Characterization of Human Bone Marrow Hematopoietic Progenitor Cells in G₀ Phase," *Workshop on Hematopoietic Stem Cell Purification and Biology*, p. 12a (1993) Abstract No. 38.

Reisbach, G. et al., "Characterization of Hemopoietic Cell Populations From Human Cord Blood Expressing c-kit," *Exp. Hematology*, 21:74-79 (1993).

Harrison, D.E. and Lerner, C.P., "Most Primitive Hematopoietic Stem Cells are Stimulated to Cycle Rapidly After Treatment with 5-Fluorouracil," *Blood*, 78(5):1237-1240 (1991).

Bodine, D.M. et al., "In Vivo Administration of Stem Cell Factor to Mice Increased the Absolute Number of Pluripotent Hematopoietic Stem Cells," *Blood*, 82(2):445-455 (1993).

Koller, M.R. et al., "Large-Scale Expansion of Human Stem and Progenitor Cells From Bone Marrow Mononuclear Cells in Continuous Perfusion Cultures," *Blood*, 82(2):378-384 (1993).

Bradley, T.R. et al., "Multiple Growth Factor Requirements of Mouse Bone Marrow Cells," *Exp. Hematology*, 16(6) (1988) Abstract No. 14.

McNiece, I.K. et al., "Human Bone Marrow Progenitor Cell Populations," *Exp. Hematology*, 16(6) (1988) Abstract No. 359.

Iscove, N.N. et al., "A Soluble Activity From Adherent Marrow Cells Cooperates With IL 3 in Stimulating Growth of Pluripotential Hematopoietic Precursors," *Blood*, 71(4):953-957 (1988).

Suda, T. et al., "Permissive Role of Interleukin 3 (IL-3) in Proliferation and Differentiation of Multipotential Hemopoietic Progenitors in Culture," *J. Cell. Physiol.*, 124:182-190 (1985).

Stewart, F.M. et al., "Post-5-Fluorouracil Human Marrow: Stem Cell Characteristics and Renewal Properties After Autologous Marrow Transplantation," *Blood*, 81(9):2283-2289 (1993).

Civin, C.I. et al., "Antigenic Analysis of Hematopoiesis. III. A Hematopoietic Progenitor Cell Surface Antigen Defined by a Monoclonal Antibody Raised Against KG-1a Cells," *J. Immunol.*, 135(1):157-165 (1984).

Sutherland, H.J. et al., "Functional Characterization of Individual Human Hematopoietic Stem Cells Cultured at Limiting Dilution on Supportive Marrow Stromal Layers," *Proc. Natl. Acad. Sci. USA*, 87:3584-3588 (1990).

Spangrude, G.J. and Johnson, G.R., "Resting and Activated Subsets of Mouse Multipotent Hematopoietic Stem Cells," *Proc. Natl. Acad. Sci. USA*, 87:7433-7437 (1990).

Ploemacher, R.E. et al., "An In Vitro Limiting-Dilution Assay of Long-Term Repopulating Hematopoietic Stem Cells in the Mouse," *Blood*, 74(8):2755-2763 (1989).

Yamasaki, K. et al., "Cloning and Expression of the Human Interleukin-6 (BSF-2/IFN β 2) Receptor," *Science*, 241:825-828 (1988).

Hibi, M. et al., "Molecular Cloning and Expression of an IL-6 Signal Transducer, gp130," *Cell*, 63:1149-1157 (1990).

Gearing, D.P. et al., "The IL-6 Signal Transducer, gp130: An Oncostatin M Receptor and Affinity Converter for the LIF Receptor," *Science*, 255:1434-1437 (1992).

Escary, J.-L. et al., "Leukaemia Inhibitory Factor is Necessary for Maintenance of Hematopoietic Stem Cells and Thymocyte Stimulation," *Nature*, 363:361-364 (1993).

Dexter, M. and Allan T., "Multi-Talented Stem Cells?" *Nature*, 360:709-710 (1992).

Huang, S. and Terstappen, L.W.M.M., "Formation of Hematopoietic Microenvironment and Hematopoietic Stem Cells From a Single Human Bone Marrow Stem Cells," *Nature*, 360:745-749 (1992).

Brandt, J. et al., "Detection of a Human Hematopoietic Progenitor Cell Capable of Forming Blast Cell Containing in Vitro," *Adv. Exp. Med. Biol.*, 241:165-173 (1988).

Reisner, Y. et al., "Enrichment for CFU-C from Murine and Human Bone Marrow Using Soybean Agglutinin," *Blood*, 95(2):360-363 (1992).

Civin, C.I. et al., "Antigenic Analysis of Hematopoiesis. VI. Flow Cytometric Characterization of My-10-positive Progenitor Cells in Normal Human Bone Marrow," *Exp. Hematol.*, 15:10-17 (1987).

Kriegler, A.B. et al., "The Relationship Between Different High Proliferative Potential Colony-Forming Cells in Mouse Bone Marrow," *Exp. Hematology*, 22:423-440 (1994).

Lerner, C. and Harrison, D.E., "5-Fluorouracil Spares Hemopoietic Stem Cells Responsible for Long-Term Repopulation," *Exp. Hematol.*, 18:114-118 (1990).

Wolf, N.S. et al., "In Vivo and In Vitro Characterization of Long-Term Repopulating Primitive Hematopoietic Cells Isolated by Sequential Hoechst 33342-Rhodamine 123 FACS Selection," *Exp. Hematol.*, 21: 614-622 (1993).

Yamaguchi, Y. et al., "Expression of c-kit mRNA and Protein During the Differentiation of Human Hematopoietic Progenitor Cells," *Exp. Hematol.*, 21:1233-1238 (1993).

Ebell, W. et al., "Depletion of Stromal Cell Elements in Human Marrow Grafts Separated by Soybean Agglutinin," *Blood*, 65(5):1105-1111 (1985).

Terstappen, L.W.M.M. et al., "Sequential Generations of Hematopoietic Colonies Derived From Single Nonlineage-Committed CD34 $^{+}$ CD38 31 Progenitor Cells," *Blood*, 77(6):1218-1227 (1991).

Zipori, D. and Lee, F., "Introduction of Interleukin-3 Gene Into Stromal Cells From the Bone Marrow Alters Hemopoietic Differentiation but Does not Modify Stem Cell Renewal," *Blood*, 71(3):586-596 (1988).

Gunji et al. *Blood* 82: 3283-3289 (1993).

Lerner, C. and Harrison, D., "5-Fluorouracil Spares Hemopoietic Stem Cells Responsible for Long-term Repopulation," *Experimental Hematology*, vol. 18, 114-118 (1990).

Stewart, F. et al., "Post-5-Fluorouracil Human Marrow: Stem Cell Characteristics and Renewal Properties After Autologous Marrow Transplantation," *Blood*, vol. 81, No. 9, 2283-2289 (1993).

DOCUMENT-IDENTIFIER: US 5827742 A

TITLE: Method of selecting pluripotent hematopoietic progenitor cells

----- KWIC -----

DEPR:

Cells were stained with propidium iodide (PI) and Hoechst 33342 (HO) as previously described (A. Pollack, G. Ciancio, METHODS IN CELL BIOLOGY, Z. Darzynkiewicz, H. A. Crissman Eds. (Academic Press, Inc. 1990) vol. 33. Cells were washed in PBS, resuspended in 100 ul PBS containing 20 .mu.g/ml propidium iodide (PI) and 10 ug/ml RNase and incubated for 30 min. on ice. Thereafter 1.9 ml of 25% ethanol and 10 .mu.l 1 mM HO-33342 (HO; Sigma, St. Louis, Mo., U.S.A.) was added and the cells were incubated for another 30 min. on ice. HO and PI fluorescence were analyzed using an EPICS 750 series flow cytometer (Coulter Electronics, Hialeah, Fla.). Fluorescence was excited by a 5 watt argon ion laser generating 40 mW of light at 351-363 nm. HO emission was detected through a 450 nm band pass filter. PI emission was detected through a 610 nm long pass filter. Fluorescence from each dye was directed to the appropriate detectors using a 560 nm short pass dichroic filter. Scattered laser light was eliminated from the fluorescence detectors by a 380 nm long pass filter.) followed by flow cytometric analysis on days 0 and 7.



US005423778A

United States Patent [19]

Eriksson et al.

[11] Patent Number: 5,423,778

[45] Date of Patent: Jun. 13, 1995

[54] SYSTEM AND METHOD FOR TRANSPLANTATION OF CELLS

[75] Inventors: Elof Eriksson, 5 Lanark Rd., Wellesley Hills, Mass. 02181; Peter M. Vogt, Newton, Mass.

[73] Assignee: Elof Eriksson, Wellesley Hills, Mass.

[21] Appl. No.: 897,357

[22] Filed: Jun. 11, 1992

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 707,248, May 22, 1991, Pat. No. 5,152,757, which is a continuation of Ser. No. 451,957, Dec. 14, 1989, abandoned.

[51] Int. Cl. 6 A61F 13/00

[52] U.S. Cl. 604/305; 604/891.1; 435/240.1

[58] Field of Search 604/304-308, 604/890.1, 891.1; 623/15; 424/DIG. 13, 574, 422, 423; 128/888; 435/41, 172.1, 240.1, 240.2, 240.21, 240.23, 240.31, 240.241, 240.243, 287, 289

[56] References Cited**U.S. PATENT DOCUMENTS**

3,026,874 3/1962 Stevens .
 3,288,140 11/1966 McCarthy .
 3,367,332 2/1968 Groves .
 3,580,254 3/1971 Stuart .
 3,814,097 6/1974 Ganderton et al. .
 4,304,866 12/1981 Green et al. 435/240.23
 4,347,841 9/1982 Benyó et al. 602/48
 4,767,746 8/1988 Catsimpoolas et al. .
 4,788,971 12/1988 Quisno .
 4,868,116 9/1989 Morgan et al. 435/240.2
 4,888,291 12/1989 Barrandon et al. 435/240.241
 4,980,286 12/1990 Morgan et al. .
 5,175,092 12/1992 Gabriels, Jr. 435/29
 5,201,728 4/1993 Giampapa 604/891.1

FOREIGN PATENT DOCUMENTS

641061 8/1950 United Kingdom .
 WO87/00201 1/1987 WIPO .
 WO91/08793 6/1991 WIPO .
 WO92/15676 9/1992 WIPO .

OTHER PUBLICATIONS

Jonathan A. Garlick et al., "Retrovirus-Mediated Transduction of Cultured Epidermal Keratinocytes", The Society of Investigative Dermatology, Inc., vol. 97, No. 5, Nov. 1991, pp. 824-829.

Jeffrey R. Morgan et al., "Expression of an Exogenous Growth Hormone Gene by Transplantable Human Epidermal Cells", Science, vol. 237, Sep. 1987, pp. 1476-1479.

James M. Wilson et al., "Implantation of Vascular Grafts Lined with Genetically Modified Endothelial Cells", Science, vol. 244, Jun. 1989, pp. 1344-1346.

(List continued on next page.)

Primary Examiner—C. Fred Rosenbaum

Assistant Examiner—V. Alexander

Attorney, Agent, or Firm—Quarles & Brady

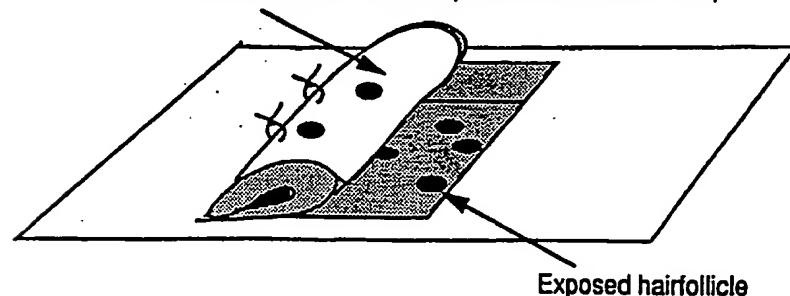
[57] ABSTRACT

Gene transfer of genetic material with viral vectors or plasmid, in combination with a wound treatment chamber, into keratinocytes, especially those including a high percentage of epidermal stem cells, has been demonstrated to be particularly effective as a means of implanting genetically engineered cells and obtaining long term survival. By employing the wound chamber system, direct *in vivo* gene transfer can also be done to exposed cells in an open wound. Skin stem cells which are located in the hair follicles are used to greatly enhance long term survival. The use of the wound chamber system for gene transfer also allows non-invasive assessment of the success of transfer by assaying for the presence of the expressed protein in wound fluid, in contrast to the prior art use of invasive techniques, such as biopsies, in order to achieve the same assessment of early expression. A wide variety of proteins and materials can be expressed, either for secretion into the general blood and lymphatic system, or to alter the properties of the protein, for example, to not express proteins eliciting an immune response against the transplanted cell.

22 Claims, 4 Drawing Sheets

Conceptional partial thickness wound model for in-vivo gene transfer

Exposed undersurface of partial thickness skin flap



DOCUMENT-IDENTIFIER: US 5423778 A

TITLE: System and method for transplantation of cells

----- KWIC -----

ABPL:

Gene transfer of genetic material with viral vectors or plasmid, in combination with a wound treatment chamber, into keratinocytes, especially those including a high percentage of epidermal stem cells, has been demonstrated to be particularly effective as a means of implanting genetically engineered cells and obtaining long term survival. By employing the wound chamber system, direct *in vivo* gene transfer can also be done to exposed cells in an open wound. Skin stem cells which are located in the hair follicles are used to greatly enhance long term survival. The use of the wound chamber system for gene transfer also allows non-invasive assessment of the success of transfer by assaying for the presence of the expressed protein in wound fluid, in contrast to the prior art use of invasive techniques, such as biopsies, in order to achieve the same assessment of early expression. A wide variety of proteins and materials can be expressed, either for secretion into the general blood and lymphatic system, or to alter the properties of the protein, for example, to not express proteins eliciting an immune response against the transplanted cell.

BSPR:

Gene transfer of genetic material with viral vectors, plasmids, or gene guns into keratinocytes, especially those including a high percentage of epidermal stem cells, in combination with the use of an "in vivo" culture chamber has

been demonstrated to be particularly effective for culture keratinocytes.

DRPR:

FIG. 1 is a schematic of the exposed undersurface of a partial thickness skin flap used to expose hair follicles to obtain epidermal stem cells. .

DEPR:

The method described herein is based on two principle components. One is the targeting of epidermal stem cells for gene transfer. The second is the use of the wound chamber in order to create an in vivo tissue culture environment, which eliminates the need to culture cells in vitro when introducing the genetic material into the cells.

DEPR:

Significant expression of both genes in this system was obtained, as shown by FIGS. 4 and 5a and b. Histologic sections of the skin showed that the keratinocytes that had the Lac Z marker gene were not stably incorporated into the basal layer, but migrated to the surface and were lost into the stratum corneum. When analyzing the reasons behind this, it was concluded that the dispase separation of dermis from epidermis did not allow for harvesting of a sufficient amount of stem cells. An additional reason was that the repeated trauma of harvesting the cells, exposure to tissue culture medium with relatively high calcium, and the cellular injury from the virus or the plasmid medium, caused a near terminal differentiation of the keratinocytes. Accordingly, results were greatly improved by using a higher percentage of epidermal stem cells obtained from the hair follicles, and decreasing the exposure to calcium and viral or bacterial medium.

CLPR:

3. The method of claim 2 wherein the cells are selected from the group consisting of keratinocytes and epidermal stem cells.

CLPR:

4. The method of claim 3 wherein the epidermal stem cells are isolated by removing the cells from hair follicles on the underside of partial thickness skin flaps.

CLPR:

13. A method for increasing the yield of genetically engineered cells in a patient comprising the steps of selecting in vivo epidermal stem cells as the cells to be engineered and introducing genetic material into said epidermal stem cells.

CLPR:

21. A method for increasing the yield of genetically engineered cells implanted in a patient, comprising the steps of selecting epidermal stem cells as the cells to be engineered, covering the implanted stem cells with a chamber, and introducing genetic material to the cells within said chamber, said chamber having an opening securable at the periphery to the skin of the patient and being formed of a flexible, moisture and gas impermeable material wherein said chamber contains the genetic material and the cells to be genetically engineered.

CLPR:

22. A method according to claim 21 wherein the step of selecting epidermal stem cells includes the step of exposing the basal layer of the patient's epidermis for the stem cells.